Can Habitable Planets co-exist with 'Hot Jupiters'?

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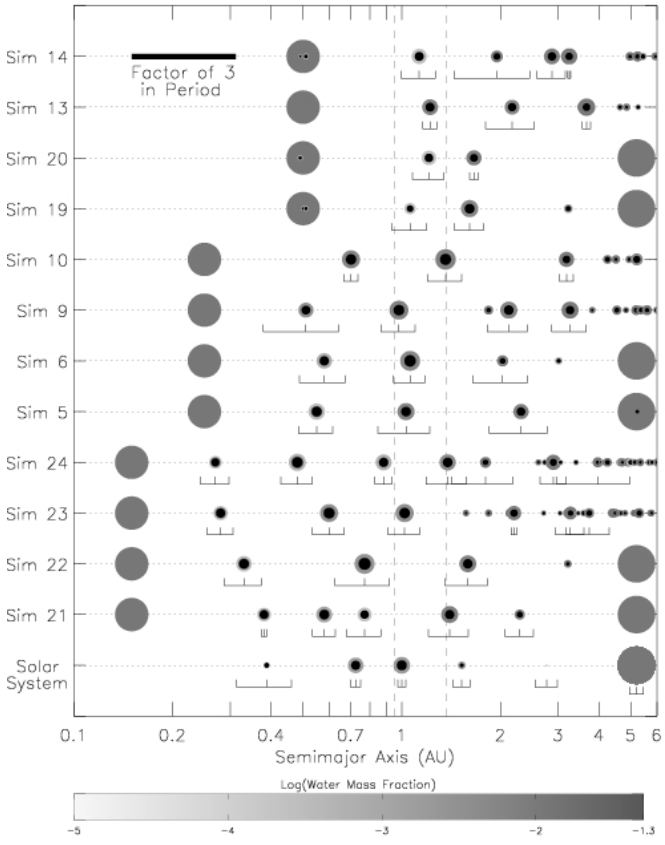
About one in a hundred stars is orbited by a 'hot jupiter,' implying the existence of roughly one billion in our galaxy. These gas giants have orbits close to their parent stars, and are thought to form at large orbital distances and migrate inward via interactions with the gaseous protoplanetary disk. If a giant planet forms and migrates inward in less than roughly one million years, terrestrial planets may form in the system.

We present results of simulations of terrestrial planet formation in the presence of 'hot' or 'warm jupiters,' broadly defined as having orbital radii within 0.5 AU of their parent star. We show that terrestrial planets similar to those in the Solar System can form around stars with hot/warm jupiters, and may have water contents equal to or higher than the Earth's. For small orbital radii of hot jupiters (e.g. 0.15, 0.25 AU) potentially habitable planets can form, but for semi-major axes of 0.5 AU or greater their formation is suppressed. A hot jupiter past 0.25 AU or with significant orbital eccentricity also causes the terrestrial planets to be depleted in iron. We speculate that asteroid belts may exist interior to the terrestrial planets in systems with hot/warm jupiters.

The figure below shows the final configuration of 12 simulations, with the Solar System shown for comparison. The large gray circles represent giant planets (not to scale with terrestrial planets). The habitable zone is marked by dashed lines.


Sim 14
Sim 13
Sim 20
Sim 19
Sim 10
Sim 9
Sim 6
Sim 5
Sim 24
Sim 23
Sim 22
Sim 21
Solar System
Factor of 3 in Period
0.1
0.2
0.4
0.7
1
2
3
4
5
6
Semimajor Axis (AU)
Log(Water Mass Fraction)
−5
−4
−3
−2
−1.3